

# NITRATES IN MUNICIPAL WATER SUPPLY CAUSE METHEMOGLOBINEMIA IN INFANT

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A 4-WEEK-OLD INFANT was stricken with methemoglobinemia in the city of B, Colo., on December 3, 1962, and the Tri-County District Health Department was notified. It was provisionally assumed that the infant had developed the disease from ingesting water with a relatively high nitrate content. Serious and occasionally fatal poisonings of infants attributed to ingestion of well water containing nitrates above the Public Health Service recommended standard of 45 mg. of nitrate per liter of water have been reported (1). However, few, if any, documented reports of such occurrences incriminate a U.S. municipal water supply, even though many such supplies have exceeded the recommended standard.

Laboratory findings confirmed the provisional diagnosis of methemoglobinemia. The nitrate content of the water ingested by the infant was shown to exceed the Public Health Service recommended standard of 45 mg. per liter, and epidemiologic investigation indicated that the municipal water was the source of the infant's illness.

## Water Supply

The city of B is located in the South Platte River Drainage Basin. Traditionally a rural area, with a population of 7,500, it is part of a rapidly expanding metropolitan area. For 75 years the city has depended on the alluvium of the South Platte River aquifer for its water supply. This productive aquifer has wells which yield from 500 to 1,000 gallons of water per minute. The static water table is from 20

to 25 feet below the ground surface. Ten shallow wells from 40 to 60 feet deep were drilled into this aquifer, and the well casings are solid to a depth ranging from 12 to 42 feet. Below the solid casings, perforated casings extend to depths of 60 feet.

Each well is pumped individually, and the water flows directly from the wells into the distribution system. After the demand throughout the distribution system has been satisfied, additional water is stored in concrete storage reservoirs and elevated steel storage tanks located throughout the city. The water is not pretreated, but each well is supplied with chlorination facilities and generally a residual of 0.1 ppm of free chlorine is maintained throughout the system. At times and in certain sections of the city, however, there is insufficient contact time before the water is used by the consumers. All bacteriological samples have been negative for coliform organisms. However, the water is highly mineralized and is contaminated with synthetic detergents. There is also the possibility of organic pollution.

## Sources of Pollution

The wells, storage reservoirs, and distribution system are fairly well constructed and protected from surface contamination.

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The city has maintained a good sewage collection system for several years. An excellent complete-treatment sewage plant was completely modernized in 1958. Not all residential units, however, are connected to the municipal sewage system. There are still 121 individual residents using cesspools, septic tanks with leaching wells, and tile leaching fields. These are located in the older section of town near the residence of the infant who contracted methemoglobinemia.

The city of B is situated so that it receives the pollution load from a metropolitan area of approximately 1 million people. This pollution is in the form of sewage and industrial wastes, which receive little pretreatment and are discharged into the Platte River. The water from the river is diverted into numerous canals and irrigation ditches and is used for agricultural irrigation. A number of the ditches flow directly through the city and are so grossly polluted that their stench creates a nuisance.

The aquifer from which the city of B derives its water supply is highly permeable and easily contaminated from surface pollution. It has suffered severe damage from various contaminating substances. These substances generally originate from both sewage and industrial wastes. Sources of wastes include individual sewage-disposal systems; chemicals from chemical industrial plants, oil refineries, and agricultural processes; and stockyards and feedlots. Synthetic detergents, nitrates, chlorides, chlorates, and sometimes chemicals resembling common herbicides have been identified. The nitrates in this aquifer could, therefore, originate from several sources: the river which is highly polluted with biological waste material and is used for extensive agricultural irrigation; nitrogen, urea, and other biological waste products used in commercial fertilizers; and individual cesspools. All of these are potential sources of nitrates and may be contributing factors in the contamination of the aquifer.

Because of the vulnerability of the aquifer and its potential hazard to public health, the Tri-County District Health Department had been concerned for some time. In 1958 the department developed an accelerated sampling and testing program to determine (a) the extent of the aquifer damage, (b) the main sources of

pollution, and (c) to what extent this shallow aquifer could be used as a source of domestic water supply. The results indicated that severe damage was occurring in the aquifer and that more intensified efforts were necessary.

Consequently, in 1959 a series of 22 surveillance wells were uniformly established throughout the aquifer. The wells were sampled and a complete analysis was made every 7 months. Two city wells within two blocks of the affected infant's residence were incorporated into this network. In February 1961 one of these wells had a nitrate content of 35 mg. per liter and the other 40 mg. per liter. In September 1961 the same wells showed a nitrate content of 40 mg. and 44 mg. per liter. In April 1962 both wells showed a nitrate content of 52 mg. per liter. At this time a meeting was held with the State health department, and it was agreed to increase the frequency of sampling of the water supply. In October 1962 the medical director of the Tri-County District Health Department notified the city's health officer, city council, and all local physicians and hospital personnel of the danger of using the municipal water for preparation of infants' formula and feeding. By November 1962 the nitrate content of these wells had risen to 62 mg. per liter.

### **Epidemiologic Investigation**

When the Tri-County District Health Department was notified of the case on December 3, a sanitarian was dispatched to the home to determine the circumstances.

The infant's family, of Spanish-American descent, consisted of the parents and two older children. The baby was on a formula of 2 ounces of evaporated milk and 2 ounces of boiled water. The mother (Mrs. L) said the baby had been progressing well while the family lived in another city. When they moved to the city of B, Mrs. L prepared the formula with the same brand of milk and this city's water.

After a few feedings the baby seemed upset and had diarrhea, which the mother attributed to the change of water. Mrs. L felt that this city's water "was hard because when she boiled the water it would leave a film on pans and bottles." To compensate for this she boiled

the water longer, but she thought that this resulted in even more film.

When the infant became quite ill and seemed to have difficulty in breathing, Mrs. L told her husband that they should take the baby to a physician. However, they had no way to get there because their car was not operating. The baby would take only a little water, and Mrs. L gave him some every half hour or so until he quieted down. Later that night when Mrs. L went to check on the baby, he had stopped breathing and was turning blue. Mrs. L picked up the baby and ran to the home of her husband's parents who rushed them to the hospital.

On admission to Colorado General Hospital at 2 a.m. on December 3, the infant was suffering with cyanosis and diarrhea, and the illness was diagnosed as methemoglobinemia. After administration of methylene blue, the baby improved, but he relapsed later and had to be retreated.

Mrs. L was asked to prepare some formula water, and she did this by boiling the water for approximately 20 minutes. The sanitarian took a sample of this water, a sample of previously prepared formula water, and a sample of tap-water.

The tapwater showed a nitrate content of 63 mg. per liter, and the two samples of formula water showed a nitrate content of 73 mg. per liter. The samples were not analyzed for the nitrite ion. It is assumed the rise in nitrates was caused by evaporation, thereby concentrating the nitrates in a smaller volume of water. However, a contributing factor might have been some conversion of nitrites during the boiling process.

When the infant was released from the hospital on December 12, the parents were given a supply of distilled water to be used for his feeding. Since then the child has progressed satisfactorily.

## Conclusions

The diagnosis of methemoglobinemia was confirmed by laboratory findings. The infant had not ingested anything other than evaporated canned milk and water, and the water contained a relatively high level of nitrates. Water containing such levels of nitrates has been previously reported to produce serious and sometimes fatal poisonings in infants. We therefore concluded that the infant was stricken with methemoglobinemia by ingestion of water from a municipal water supply which exceeded the Public Health Service recommended standard for nitrates in drinking water.

## Followup

Since all wells used by the city of B as a source of municipal water were highly mineralized and were above the Public Health Service recommended standard of 45 mg. of nitrate per liter of water, the Tri-County District Health Department recommended that the city obtain a new source of water which would meet the recommended standards for drinking water. Also, the department, in cooperation with the city council, notified the public and all physicians and hospitals by mail and through the newspapers that the city of B's drinking water exceeds the recommended standards for nitrate content, and it should not be used to prepare formula or for drinking by infants under 6 months of age.

The Tri-County District Health Department has obtained both financial and technical assistance from the State health department and the Public Health Service to perform an extensive survey on underground pollution in the area of the city of B.

## REFERENCE

- (1) Walton, G. : Survey of literature relating to infant methemoglobinemia due to nitrate-contaminated water. *Amer J Public Health* 41 : 986-996, August 1951.

## Program Notes

### **Court Upholds Fluoridation Code**

The Supreme Court of New York City recently upheld the New York City Health Code requirement for fluoridation of the city's water supply.

In the February 15, 1965, decision, the court said in part: "The problem still remains fundamentally one of health and is therefore within the jurisdiction of the New York City Department of Health." The court also noted that the United States Supreme Court has either dismissed appeals or denied a review in cases which squarely presented as the primary question the constitutionality of fluoridation of a water supply.

### **Air Pollution and Scuba Divers**

Scuba divers, when propelled into the sea, may be exposed to greater danger from air contaminants than persons living in the most polluted urban environment.

A New York City Special Committee to Investigate Air Pollution has noted the danger to divers who use scuba tanks filled with compressed air drawn, without further processing, from the polluted city atmosphere.

As the diver penetrates to greater depths, the lung pressure increases and noxious gases in the air he breathes are more readily absorbed into his tissues. The pressure at a depth of 27 feet, for instance, is double that of the surface atmosphere, and it increases steadily at greater depths.

### **Retardation Rehabilitation Project**

The Crossroads Rehabilitation Center in Indianapolis, Ind., has organized a developmental program of therapy and training in motor-perceptual skills for preschool retarded and brain-damaged children.

For 2½ hours daily, 5 days a week, staff members work with 15 children who have been unable to gain admittance to special classes, regular

kindergarten, or first grade because of their low achievement levels. The project, conducted in cooperation with the Purdue University Achievement Center, Lafayette, is supported by the Indiana State Board of Health and the Tippecanoe County Medical Society.

### **Wigwam Waste Burners**

The Oregon State Sanitary Authority, on June 24, 1965, adopted regulations on the construction and operation of wigwam waste-burners of wood. The agency is preparing copies of the regulations for distribution.

The Oregon State University Engineering Experiment Station has also prepared a publication entitled "Wood Residue Incineration in Teepee Burners," Circular No. 34, which is to be distributed to all civil and mechanical engineers and members of wood products industries in Oregon.

Wood product industries use wigwam burners to dispose of wood residue by burning. Poor combustion in these causes air pollution in lumber areas.

### **Public Health Internships**

Thirty-eight medical students worked in New York during the summer of 1965 as junior public health interns. Each was supervised by a public health physician of a State or local health department.

The intern program has given summer experience to more than 400 medical students since it was established in 1946. A number of these interns later choose careers as public health physicians, according to Dr. Hollis S. Ingraham, State Health Commissioner of New York.

### **Laboratory Tests on Doctors**

Nearly 2,400 persons, mostly doctors, attending the American Medical Association convention in June 1965 underwent screening examinations at an exhibit laboratory.

More than half of those tested

talked over the significance of their test results with pathologists, and if they had been through the laboratory before, compared results with those of other years. The remaining reports were mailed to screenees after the convention.

Test data are being analyzed to determine the role of clinical pathology examinations in health evaluation.

### **Smallpox Diagnosis Changed**

The diagnosis of a case of smallpox in Washington, D.C., confirmed on May 27, 1965, by the Public Health Service's Communicable Disease Center, Atlanta, Ga., was subsequently amended to chickenpox on the basis of final virological and histological examination of specimens.

When the original vascular fluid was inoculated onto the chorioallantoic membranes of eggs, distinct "pocks" were observed. Continued testing, however, showed that these pocks were nonspecific and occurred irregularly on the chorioallantoic membranes of eggs purchased from a particular vendor.

### **Health Services High School Course**

A special class in laboratory health services will enable 12th grade pupils with a background in biology, chemistry, or mathematics at Cincinnati's Courter High School to earn a high school diploma and at the same time prepare for college or entry into health-related occupations.

Basic concepts, manipulative skills, technological laboratory experiences, and field investigations will be taught two periods daily.

### **Safety Rules for Skateboarding**

The Illinois Department of Public Health, division of preventive medicine, recently issued safety rules recommended by the National Safety Council to minimize skateboarding accidents.

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*Items for this page: Health departments, health agencies, and others are invited to share their program successes with others by contributing items for brief mention on this page. Flag them for "Program Notes" and address as indicated in masthead.*

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